



The US Natural Gas Industry *Research & Technology Challenges*

> Presented to:

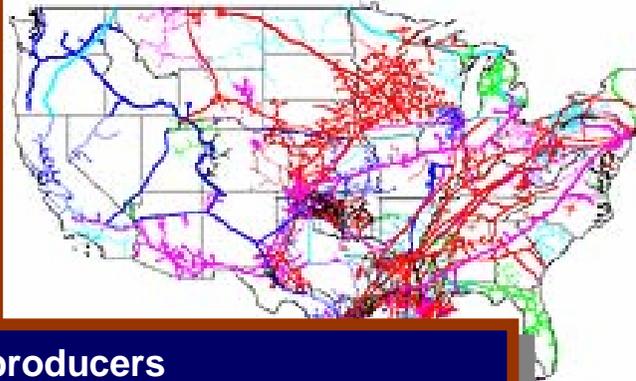
Pipeline Research & Development Forum

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Gas Infrastructure: Large, Complex

Gas Production

25 major producers
8,000 independent producers
272,500 gas wells
Some production 100 miles offshore



Gas Delivery

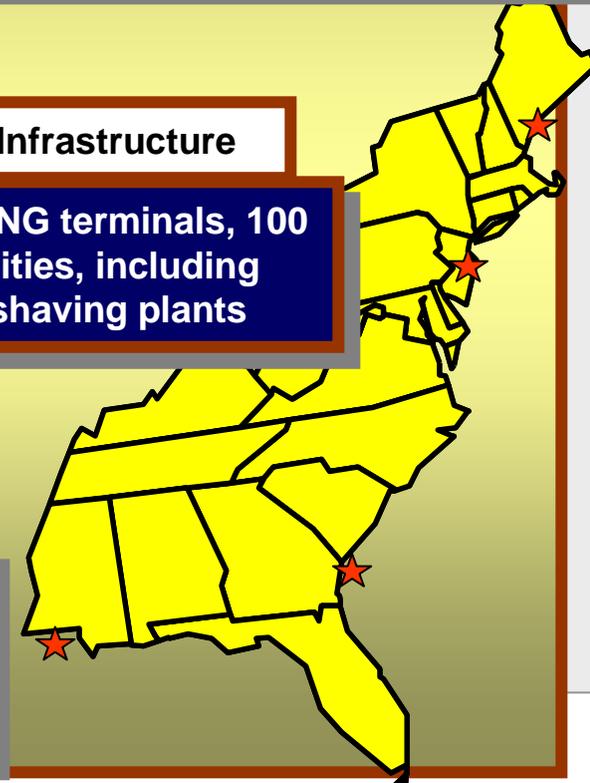
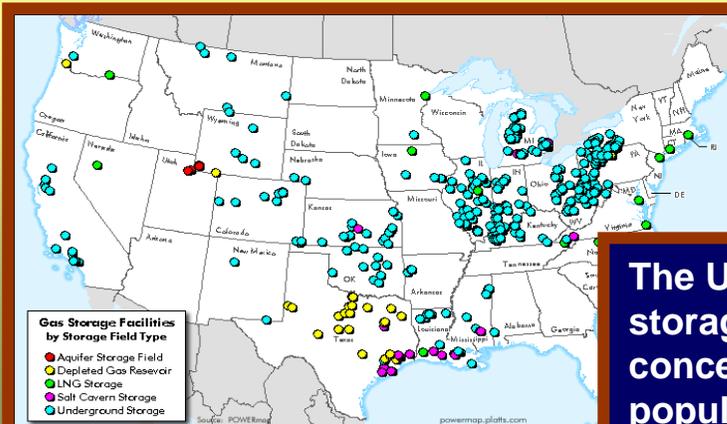
Transmission Lines: 298,000 miles
Gathering lines: 200,000 miles
Distribution lines: 1,000,000 miles
High consequence areas: 28,900 miles

LNG Infrastructure

★ Four LNG terminals, 100 LNG facilities, including peaking/shaving plants

Gas Storage

The US has 410 underground storage facilities, which are concentrated in highly populated areas of the Midwest



Gas Industry Challenges

- > Adequate Domestic Supply
- > Reduced Price Volatility
- > Predictable Prices in Line with Industrial Market
 - Industrial Demand Decreased 20% from 1997 to 2002
 - Fertilizer Manufacturing Goes Offshore at \$4.00/mcf
- > Secure Infrastructure

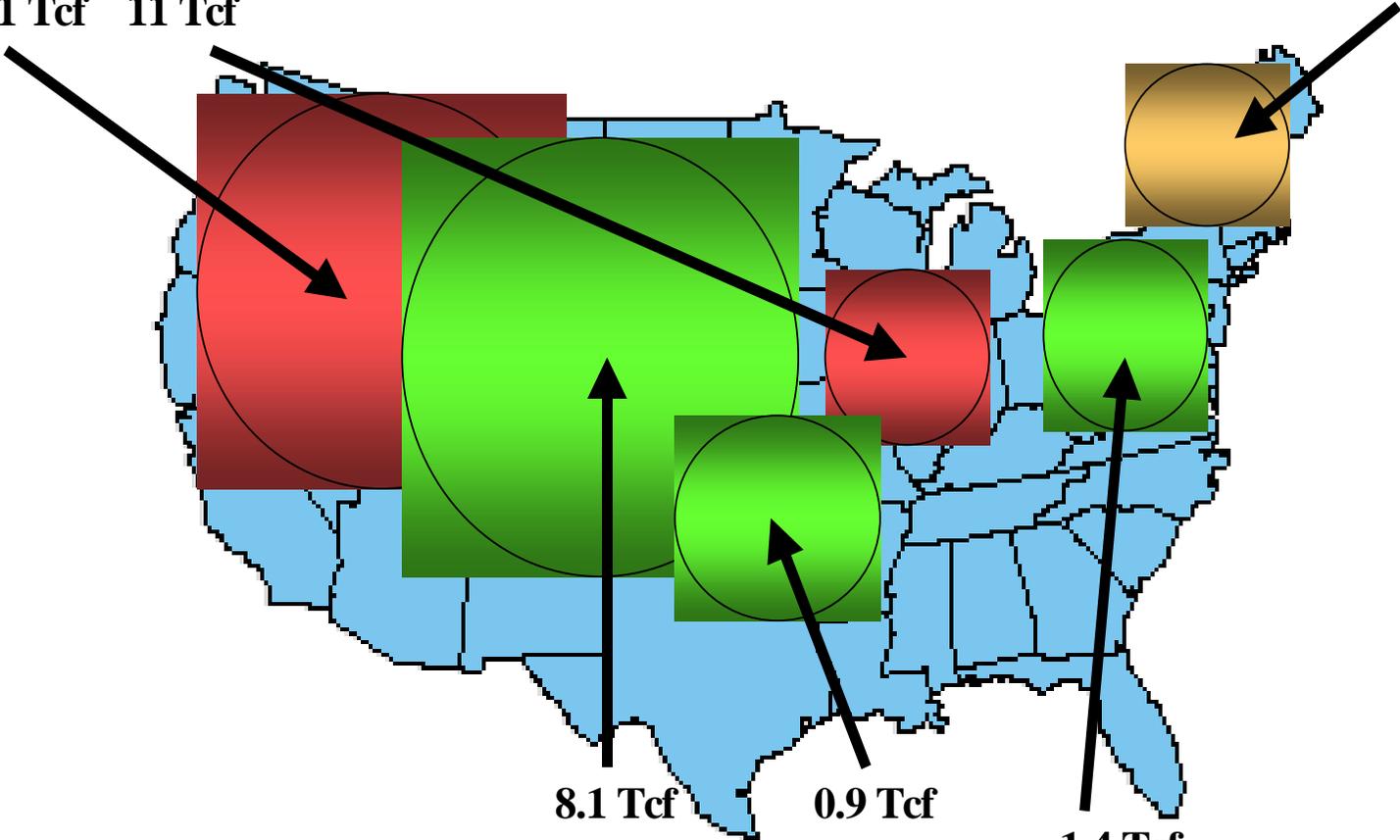
Unconventional Gas: Proved Reserves

Tight Sands

8.1 Tcf 11 Tcf

Gas Shales

3.4 Tcf



Coalbed Methane



Source: Bureau of Economic Geology, UT

LNG Costs and Infrastructure

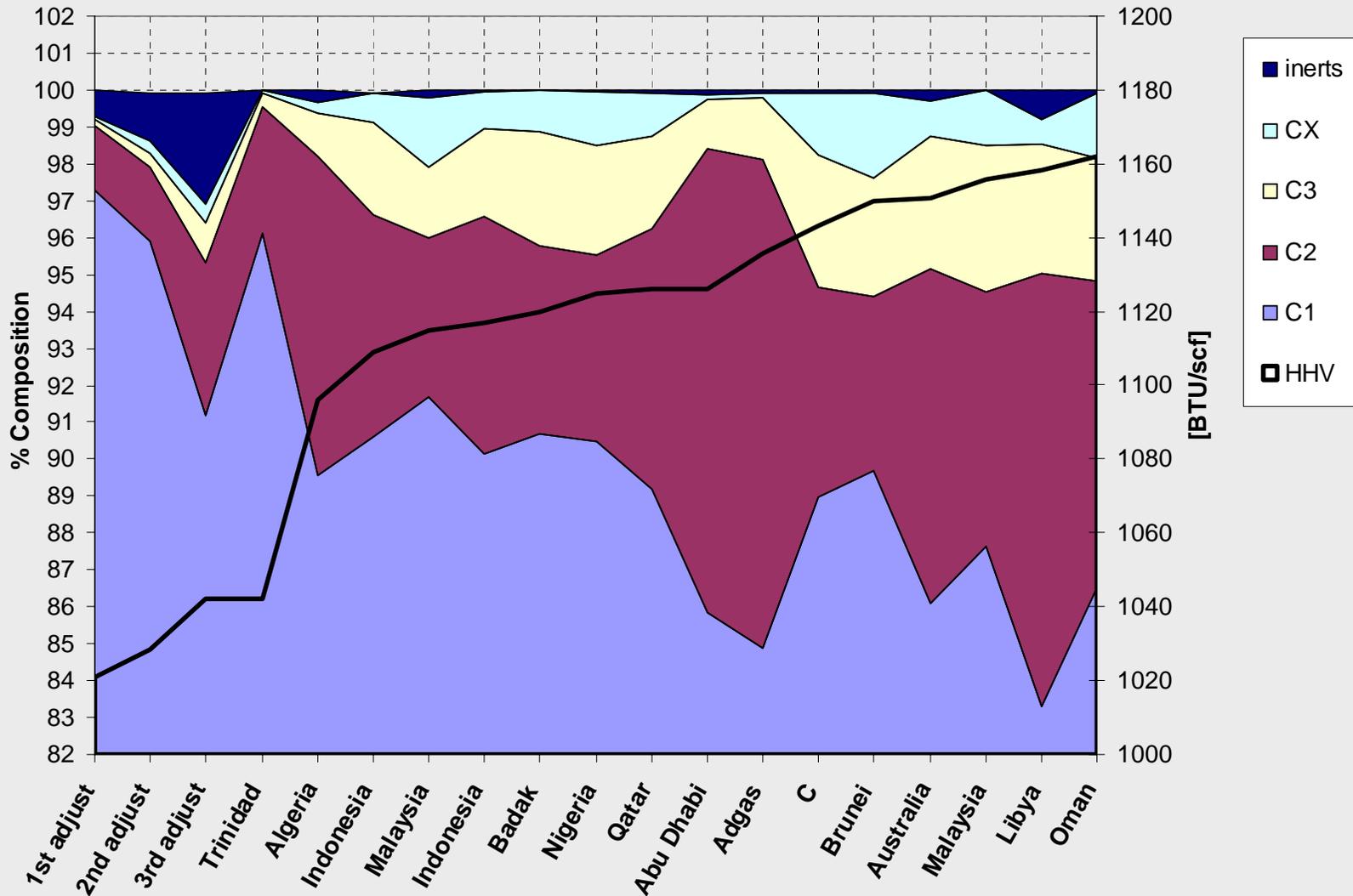
> Gas Production:\$.30 - \$1.30
> Liquefaction:\$1.00 - \$2.50
> Shipping.....\$.60 - \$1.10
> Regasification.....\$.40 - \$1.50
TOTAL:	\$2.30 - \$6.40

Source: GTI LNG Source Book, 2001

- > 17 LNG Liquefaction (Export) Terminals
- > 40 Regasification (Import) Terminals
- > 130 LNG Tankers (120 M Metric Ton Capacity)



U.S. Natural Gases (adjust gases) and World LNGs



Study of LNG Interchangeability

- > GTI conducted a study for 7 sponsors to determine interchangeability of LNGs in new domestic appliances
- > Study identified most sensitive appliance burners and ranges of unacceptable performance
- > New study planned to extend study of LNG interchangeability to industrial burners and turbines with demanding efficiency and emissions requirements



Natural Gas (water heater)



LNG



LNG with 10% air

Research & Technology Needs

> NDE Technology & Services

- Develop advanced ILI (in-line inspection) sensors and data interpretation; Locate and characterize mechanical damage, corrosion, stress corrosion cracking, coating disbondment.

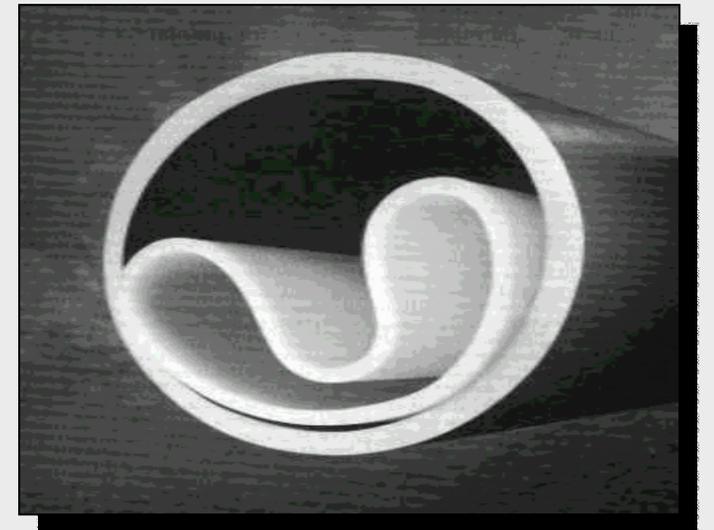


- **ILI sensors and delivery vehicles for unpiggable lines.**
- **ILI pig testing and certification facility; evaluate in-pipe performance of sensors and data interpretation.**



Research & Technology Needs

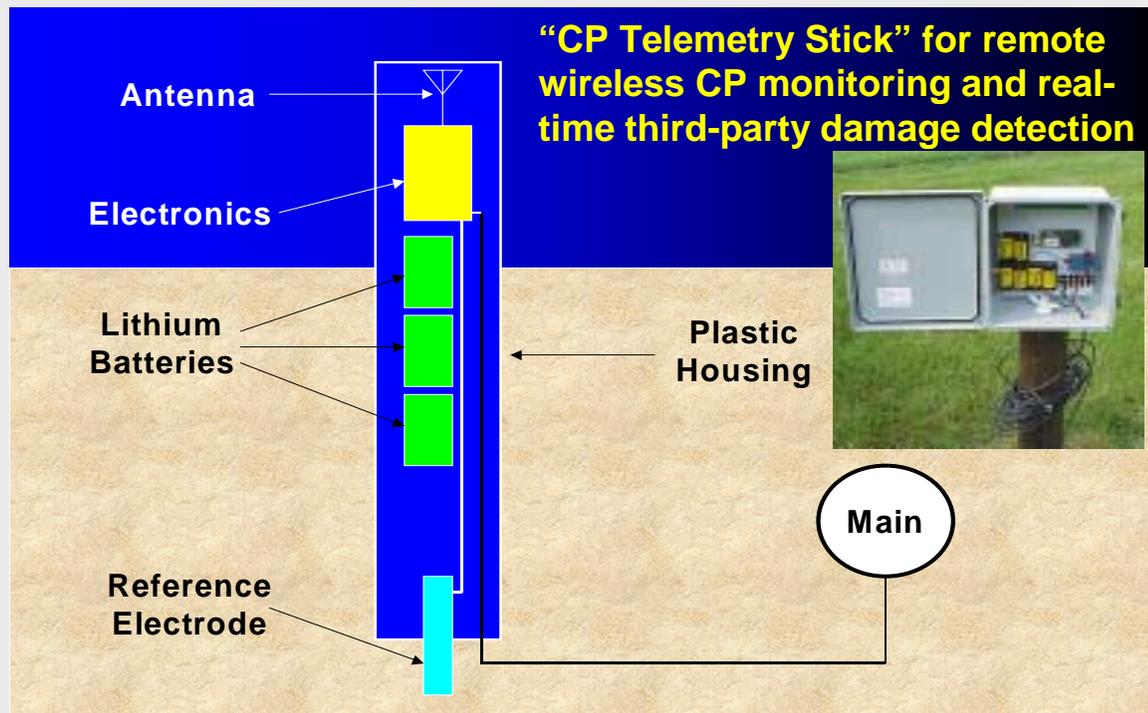
- > Pipeline Corrosion Control
 - Systems for the detection, mitigation, prevention of external, internal and & MIC (microbially-induced corrosion)
 - Improved coatings for better reliability and compatibility with other coatings; easier to apply, last longer, less costly
 - Better understanding and management of Stress Corrosion Cracking



Research & Technology Needs

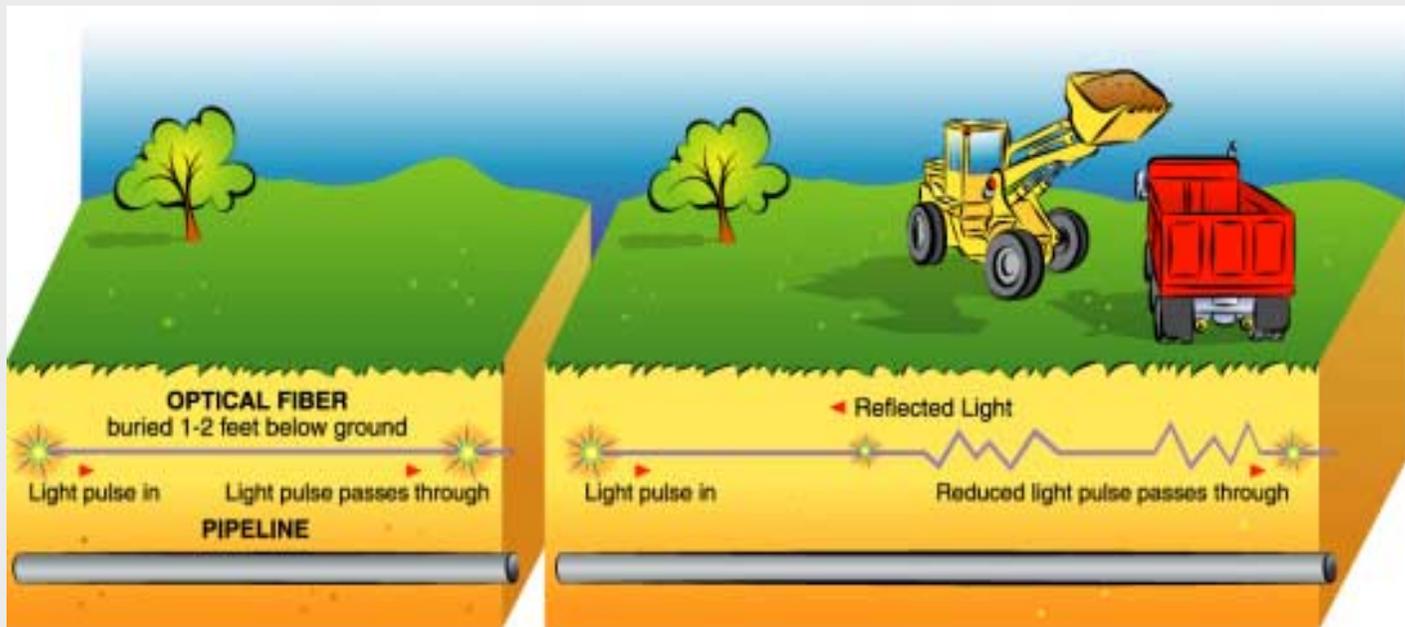
> Corrosion Control (cont'd)

- Systems that ensure that proper cathodic protection is being maintained and determine the effectiveness of CP systems; remote wireless monitoring of impressed current CP performance



Research & Technology Needs

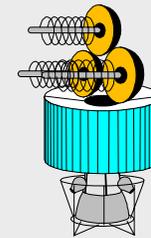
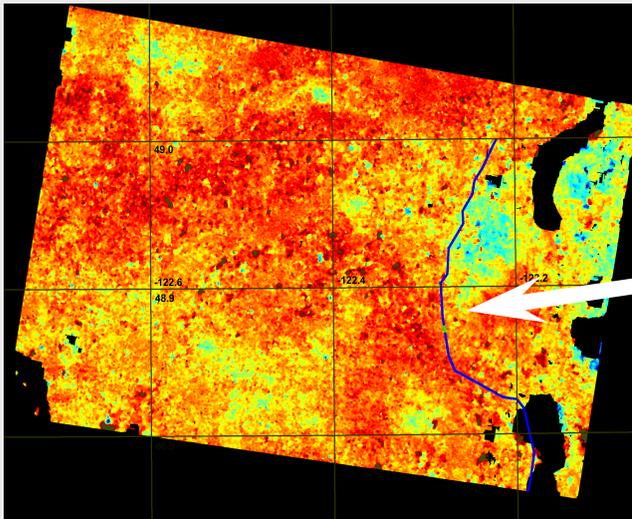
- > Pipeline Right-of-Way Management (cont'd)
 - Systems to detect encroachment of digging equipment before contact is made with buried pipe



- Systems to provide real-time monitoring and alert of third-party damage to buried pipelines

Research & Technology Needs

- Pipeline Right-of-Way Management (cont'd)
 - Remote detection of Subsidence & Earth Movement



3.5" over 6 months

Deformation Map, Everson, WA

- Education and communication in support of effective one-call systems; Common Ground Alliance

Research & Technology Needs

- > New pipeline materials
 - Stronger, tougher, more damage and defect resistant pipe
 - > **X80 & X100 Steels**
 - > **Fracture initiation and control**
- > Safe operation of early pipelines
 - 50% of existing gas pipelines over 50 years old
 - Repair and rehabilitation
- > Management and repair of in-service damage
 - Keeping lines safely in service to assure deliverability
- > Safer more reliable construction & maintenance welding



GTI Technologies For Safer, More Reliable Pipeline Infrastructure

